2013-06-14

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Springer-Verlag Berlin Heidelberg

Arch Gynecol Obstet 288 (2013), p. 1285-1293
http://hdl.handle.net/10945/48293

Arch Gynecol Obstet (2013) 288:1285–1293
DOI 10.1007/s00404-013-2904-y

MATERNAL-FETAL MEDICINE

Can major systematic reviews influence practice patterns? A case study of episiotomy trends

Yu-Chu Shen · Wee Chung Sim · Aaron B. Caughey · David H. Howard

Received: 5 March 2013 / Accepted: 16 May 2013 / Published online: 14 June 2013

Abstract
Purpose Episiotomy is one of the most commonly performed procedures among women of childbearing age in the United States. In 2005, a major systematic review conducted by Hartmann and colleagues recommended against routine use of episiotomy and was widely covered in the media. We assessed the impact of the Hartman et al. study on episiotomy trend.
Methods Based on 100 % hospital discharge data from eight states in 2003–2008, we used interrupted time series regression models to estimate the impact of the Hartman et al. review on episiotomy rates. We used mixed-effects regression models to assess whether interhospital variation was reduced over time.
Results After controlling for underlying trend, episiotomy rates dropped by 1.4 percentage points after Hartman et al. publication ($p < 0.01$ for spontaneous delivery; $p < 0.1$ for operative delivery). The publication has smaller effect on government hospitals as compared to private hospitals. Mixed effects models estimated negative correlation between cross-time and cross-hospital variations in episiotomy rates, indicating reduced cross-hospital variation over time.
Conclusions Our results suggested that there has been a gradual decline in episiotomy rates over the period 2003–2008, and that synthesis of evidence showing harms from routine episiotomy had limited impact on practice patterns in the case of episiotomy. The experience of episiotomy illustrates the challenge of using comparative effectiveness and evidenced-based medicine to reduce use of unnecessary procedures.

Keywords Episiotomy · Practice pattern · Interrupted time series regression models

Introduction

The Patient Protection and Affordable Care Act included a dedicated funding line for comparative effectiveness research (CER) as a way to reduce healthcare costs in the United States. However, the true value of any CER lies in its impact on practice patterns following these publications. In this paper, we use episiotomy as a case study to examine how practice pattern changed over time following a widely publicized study that reports no benefit.

Introduced in the eighteenth century to facilitate vaginal delivery, episiotomy is one of the most frequently performed operative procedures among women between the ages of 18 and 44 in the United States [1]. The American Gynecological Society advocated for routine adoption of episiotomy in the 1920s [2], and the procedure gained popularity in the mid twentieth century. In the 1980s and

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1990s, several clinical trials conducted outside of the US found that routine episiotomy provided no benefit to mothers [3–7]. Based on the concerns about the appropriateness of episiotomy, rates steadily declined over time in the US [8–10], although many women continue to receive the procedure.

In 2005, a major systematic review on the outcomes of routine episiotomy conducted by Hartmann and colleagues was published in the *Journal of American Medical Association* (JAMA) [11]. Based on trials and other studies published between 1950 and 2004, the authors concluded that there are no benefits to routine episiotomy. Although the paper was not the first to recommend a policy of restrictive episiotomy [12] and did not present results of an original comparative effectiveness analysis, it summarized results from comparative effectiveness studies in a way that clarified the impact of episiotomy on patient outcomes. Although there were other meta-analysis of maternal outcomes preceding this study [13, 14], the Hartman study was widely covered in the media, including national newspapers such as the *Los Angeles Times*, *the Washington Post*, and *the Wall Street Journal* [15–17], regional newspapers, national wire services, such as the *Associated Press* [18], and nightly news broadcasts [19, 20].

The coverage may have affected expectant mothers' perceptions of the effectiveness of episiotomy. Based in part on the review, the American College of Obstetrics and Gynecology (ACOG) changed its practice guideline in 2006 to recommend against routine episiotomy [21].

Although several recent studies have reported trends in episiotomy rates through the mid 2000s [8, 10, 19], none has focus on comparing the trends in episiotomy rates before and after publication of the JAMA review or investigating practice variation across different institutional settings. We report trends in episiotomy rates for the period 2003–2008 and changes in practice variation during this period.

Our study extends previous works in several ways beyond documenting episiotomy trend. First, we use an interrupted time series regression model to analyze whether episiotomy rate, which has been declining steadily during this period, shows an additional statistically significant drop after the publication of the Hartman et al. study. Second, we investigate whether there is differential trends by hospital's organizational factor (teaching vs. non-teaching, private vs. public) since physicians in different institutional settings might have different receptions to the same information [22]. Lastly, we estimate a mixed-effects model to investigate whether practice variation has reduced over time across hospitals, another evidence of broader adoption of evidence-based medicine.

Materials and methods

Data sources

The Healthcare Cost and Utilization Project State Inpatient Databases (SID) are the primary data source for the analysis. These databases capture 100 % or close to 100 % of hospital discharges, depending on the state. The discharge data contain diagnostic and procedure information for each inpatient care episode, as well as basic patient characteristics (including age, race, gender, and insurance coverage). We obtained SID for 2003–2008 from eight states: Arizona, California, Florida, Massachusetts, Maryland, New Jersey, New York, and Washington. Together, the eight states account for 36 % of the US female population in 2009. Although the age distribution is similar between the eight states and the national average, Hispanics are overrepresented (23 % in the sample vs. 15 % nationwide; see the "Appendix"); we supplemented the SID with the American Hospital Association annual surveys over the same period to obtain additional hospital characteristic not available in the SID (such as hospital ownership, teaching status, and the size of the maternity ward). The study was exempted from Institutional Review Board approval because the study meets the criteria for research that does not involve human subjects according to the National Institute of Health guidelines.

Sample

We identified women undergoing spontaneous vaginal delivery and operative vaginal delivery (i.e., forceps- and vacuum-assisted) using ICD-9 codes. We excluded the following types of deliveries: cesarean deliveries, multiple gestations, preterm deliveries (<37 weeks' gestational age), breech deliveries, and deliveries that involve maternal and fetal complications (such as ectopic and molar pregnancy, fetal abnormality). We identified women undergoing episiotomy using ICD-9 code 73.6 for spontaneous vaginal deliveries and codes 72.1, 72.21, 72.31, 72.71 for operative deliveries.

Statistical analysis

We report quarterly trends in episiotomy rate between 2003 and 2008 separately for spontaneous and operative deliveries. We computed the episiotomy rate as the percent of deliveries where an episiotomy was performed for all deliveries of a given type during the calendar quarter.

We used an interrupted time series regression model to estimate the impact of the publication of the Hartman et al. review on episiotomy rates [23–25]. The advantage of an interrupted time series analysis over alternative estimation methods (such as fitting a nonlinear line using ordinary least square or implementing a piecewise regression) is that it allows an explicit statistical test to detect a shift or change in underlying episiotomy trends due to an event (in this case, the publication of the Hartman et al. study and the immediate media coverage). In addition, the coefficient from the model can be easily interpreted. We estimated separate models for spontaneous and operative deliveries. The dependent variable is an indicator for whether or not the woman underwent an episiotomy during her delivery. In our main model, the key independent variables are (1) a time trend variable, measuring the number of quarters since 2003, (2) an indicator for the period after publication of the Hartman et al. review (taking the value of 1 for deliveries that occurred on or after the 2nd quarter of 2005), and (3) a variable that measures the trend after publication of the Hartman et al. review. The first variable measures the baseline trend in episiotomy rates, the second measures the immediate impact of the publication of the Hartman et al. review on episiotomy rates (i.e., whether the study resulted in an intercept shift in the underlying episiotomy trend), and the third measures the change in the trend in rates following publication of the Hartman et al. review (i.e., a slope change of the underlying episiotomy trend).

We used a linear probability model (i.e., least squares regression) to estimate the impact of the independent variables on the likelihood that a woman giving birth underwent episiotomy. Although a logistic model is the natural choice for modeling a dichotomous-dependent variable, it would result in an inconsistent estimator in our case because we are including a significant number of hospital fixed effects. A linear probability model will provide consistent estimates [26, 27]. One concern with using a linear probability model is that it will result in heteroskedastistic errors. For all models, we estimated heteroskedasticity robust standard errors [28], which allow for intra-hospital correlation among patients who delivered babies in the same hospital. All models were estimated using Stata version 11 [29].

We controlled for patient and hospital characteristics: patient age (18–24, 25–29, 30–34 and 35 and above), patient race/ethnicity (white, black, Hispanic, other and unknown race), patient insurance coverage (Medicaid, private insurance, other sources including self-pay and no charge), hospital ownership (not-for-profit, for-profit, and public), whether a hospital is a teaching hospital as defined by membership in the Council of Teaching Hospitals, and the level of obstetric care (level 1 hospitals are capable of providing care to uncomplicated cases while level 3 hospitals are capable of providing care to all serious and abnormal cases). We also controlled for the annual number of births and patient demand relative to capacity (proxy by births per bassinet ratio). Practitioners may be more inclined to perform episiotomies when the hospital is near or at capacity to accelerate delivery [30]. We included hospital fixed effects in the model. Including hospital fixed effects is equivalent to including dummy variables for each hospital in the regression model. They control for any time-invariant unobserved variations across hospitals and states that may affect baseline episiotomy rates. In other words, any baseline differences across hospitals (and therefore states) would be absorbed by the hospital dummies, and would not introduce bias in our estimated effect of the JAMA study.

For each delivery type, we estimated two additional models that allow the JAMA publication's potential effect to differ by hospital characteristics. Prior study found that private obstetricians are more likely to perform episiotomy compared to faculty practitioners [31]. In model 2, we add interaction terms between hospital's teaching status and the two JAMA variables (post-JAMA indicator and variable capturing post-JAMA time trend) to capture possible differential responses to the synthesis review between teaching and non-teaching hospitals. The previous studies have found that episiotomy rate vary widely across hospitals and that provider type is an important factor that might affect episiotomy rate [22]. In model 3, we add interactions between hospital ownership (for-profit, government) and the two JAMA variables to investigate differential responses to the synthesis review across hospital ownership.

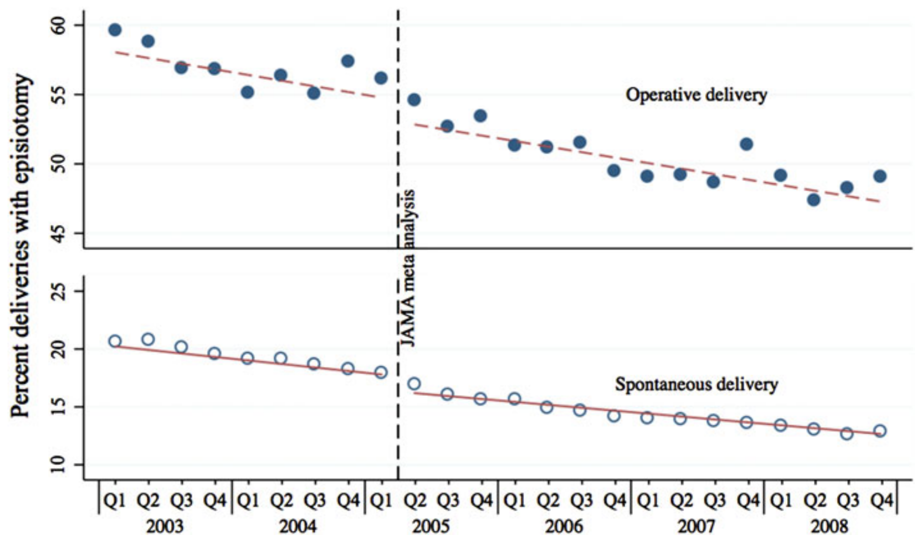
Publication of the Hartmann et al. review may have affected both the episiotomy rate and the variation in episiotomy rates between hospitals. We calculated the percent of spontaneous and operative deliveries in which an episiotomy was performed by delivery type and year for each hospital. We calculated the average rate, the interquartile range, and the standard deviation. We re-estimated the regression model using a mixed effects specification with a random effect for hospital and an interaction between hospital and time to estimate the correlation between cross-time variation and cross-hospital variation in episiotomy rate. We excluded 234 hospitals that performed fewer than ten deliveries in a year.

Results

Trends in episiotomy rates

The data include observations for 4.7 million spontaneous deliveries and 76,883 operative deliveries. Figure 1 displays trends in episiotomy rates by delivery type, spontaneous or operative. The dashed vertical line represents the publication date of the systematic review (4 May 2005). Episiotomy rates in spontaneous deliveries declined from

Fig. 1 Overall and predicted episiotomy rate by delivery type: 2003–2008 (AZ, CA, FL, MA, MD, NJ, NY, WA). Source: Author's analysis of the State Inpatient Databases



21 % in the first quarter of 2003 to 13 % in the last quarter of 2008. Episiotomy rates in operative deliveries declined from 60 to 49 %.

Table 1 displays characteristics of the patient sample and the hospitals that admitted those patients. Episiotomy rates are higher for operative deliveries versus spontaneous deliveries (53 vs. 16 %). The majority of patients were between the ages of 18 and 29 when they gave birth (57 and 63 % among spontaneous and operative deliveries, respectively). Half of the mothers were covered by private insurance, and over 40 % were covered by Medicaid. Among spontaneous deliveries, three-quarter of all deliveries occurred in not-for-profit hospitals and 24 % occurred in teaching hospitals. Among operative deliveries, 67 % occurred in not-for-profit hospitals and 14 % occurred in teaching hospitals.

Regression analysis

Table 2 displays results from the regression models for each delivery type. Models 1 and 4 are the main models for spontaneous and operative deliveries, respectively. Models 2 and 5 add interaction terms between teaching status and the key JAMA variables, and models 3 and 6 add interaction terms between hospital ownership and the JAMA variables. The coefficients represent the impact of each variable on the probability of receipt of an episiotomy, with positive values corresponding to higher episiotomy rates. For example, the coefficient on the indicator variable for private insurance coverage in model 1 indicates that episiotomy rates are 4.4 percentage points higher for women with private coverage as compared to women in the omitted category, Medicaid, controlling for the other patient and hospital characteristics.

The solid lines in Fig. 1 represent the regression-adjusted trends in episiotomy rates. The slope and position of the line depend on the intercept term and the coefficients listed in the first three rows in Table 2. The coefficients on the variable measuring time in quarters since 2003 indicate that prior to publication of the Hartman et al. review, episiotomy rates were declining by one-third of one percentage point each quarter for spontaneous deliveries and 0.4 of one percentage point for operative deliveries ($p < 0.001$ for both). Model 1 indicates that episiotomy rates dropped by an additional 1.4 percentage points among women undergoing unassisted vaginal delivery ($p < 0.001$) after the Hartman et al. publication. The model for operative deliveries indicates that the episiotomy rate declined by a similar magnitude (1.5 percentage points, $p = 0.10$), but the coefficient is only significant at the 10 % level due to smaller sample size. In neither model is the coefficient on the post-Hartman trend variable, representing a change in the rate of decline in episiotomy rates after publication of the Hartmann et al. review, significant. In other words, there appears to be a small immediate drop in the episiotomy rate following the Hartman et al. publication, but the study did not change the slope of the trend beyond the initial decline.

Model 2 shows that among spontaneous deliveries, there does not appear to be differential trend between teaching and non-teaching hospitals post JAMA publication. Model 3 shows that the JAMA publication has a smaller immediate effect on government hospitals' episiotomy rate as compared to not-for-profit hospitals, by 1.3 percentage point ($p < 0.01$). However, it should be noted that government hospitals' baseline episiotomy rate is lower than that of private hospitals (2.4 percentage point). We observe the same pattern for operative deliveries in Model 6—the

Table 1 Patient and hospital characteristics 2003–2008

	Spontaneous deliveries *N* (%)	Operative deliveries *N* (%)
Episiotomy rate	758,976 (16)	40,850 (53)
Patient characteristics		
Age		
18–24	1,421,330 (30)	27,951 (36)
25–29	1,278,904 (27)	20,995 (27)
30–34	1,152,359 (25)	18,226 (24)
35 and above	847,837 (18)	9,711 (13)
Payment source		
Medicaid	1,901,019 (40)	34,416 (45)
Self-pay/no charge or others	279,465 (6)	4,387 (6)
Private insurance	2,519,946 (54)	38,080 (50)
Race		
White	1,927,323 (41)	28,654 (37)
Black	466,134 (10)	5,385 (7)
Hispanic	1,348,377 (29)	26,456 (34)
Other races[a]	537,155 (11)	10,054 (13)
Unknown races[b]	421,441 (9)	6,334 (8)
Hospital characteristics		
Hospital ownership		
For-profit	531,452 (11)	17,081 (22)
Not-for-profit	3,534,617 (75)	51,803 (67)
Government	634,361 (13)	7,999 (10)
Teaching hospital		
Teaching	1,114,601 (24)	10,494 (14)
Obstetric level[c]		
Non-obstetric	948,988 (20)	15,570 (20)
Obstetric level 1	787,246 (17)	14,817 (19)
Obstetric level 2	1,343,972 (29)	23,059 (30)
Obstetric level 3	1,620,224 (34)	23,437 (30)
Mean annual births (SD)	3,246 (2,397)	2,888 (1,990)
Mean bassinets (SD)	35 (26)	29 (22)
Number of patients	4,700,430	76,883
Number of hospitals	1,049	795

Generated from data extracted from State Inpatient Discharge Database and American Hospital Association Annual Hospital Surveys: 2003–2008

[a] Other races refer to Asians, Pacific Islanders, Native Americans and other races

[b] Unknown races refer to observations with missing value in race

[c] Obstetric unit care level: level 1 refers to hospitals that "provide services for uncomplicated maternity and newborn cases"; level 2 "provide services for all uncomplicated maternity and most complicated cases"; and level 3 "provide services for all serious illnesses and abnormalities"

synthesis review has much smaller effect on government hospitals' episiotomy trend.

Our results are stable whether we include or exclude the capacity measures. We also performed a stratified analysis of the models by hospital's baseline episiotomy rate—hospitals with low baseline rate might have no room for further decline in episiotomy rate and therefore would demonstrate smaller reaction to the Hartman et al. study. We classify hospitals into low and high episiotomy rate group based on their baseline episiotomy rate (i.e., mean rate during the first year). A hospital is in the low rate group if its baseline rate is below the 50th percentile. We found that the results are similar across the two groups (results available upon request) and do not affect the conclusions we obtain from the main analysis.

Interhospital variation

Figure 2 displays box and whisker plots of episiotomy rates across 759 hospitals that performed at least ten spontaneous deliveries annually between 2003 and 2008. The plot shows that interhospital variation in episiotomy rates declined between 2003 and 2008—the interquartile ranges decreased from 16 percentage points in 2003 to 2012 percentage points in 2008 and the standard deviation decreased from 12 percentage points in 2003 to 2010 percentage points in 2008. The variation of episiotomy use among operative deliveries declined between 2003 and 2006, but widened after 2006. Mixed effects models estimated that the correlation between cross-time variation and

Table 2 Multivariate results

Coefficient (SE)	Spontaneous delivery			Operative delivery		
	(1)	(2)	(3)	(4)	(5)	(6)
Time (quarterly)	−0.30** (0.03)	−0.30** (0.03)	−0.30** (0.03)	−0.41** (0.12)	−0.41** (0.12)	−0.41** (0.12)
Indicator for period on and after JAMA publication	−1.36** (0.14)	−1.45** (0.17)	−1.60** (0.16)	−1.54+ (0.93)	−2.02* (1.00)	−2.37** (0.88)
Time trend after JAMA publication	0.05+ (0.03)	0.05+ (0.03)	0.04 (0.03)	0.01 (0.15)	0.09 (0.16)	0.07 (0.15)
Teaching × on and after JAMA publication		0.44 (0.43)			3.81+ (2.01)	
Teaching × time trend after JAMA		−0.01 (0.03)			−0.62** (0.18)	
For-profit × on and after JAMA publication			0.61 (0.48)			0.82 (2.57)
For-profit × time trend after JAMA			−0.01 (0.05)			−0.06 (0.29)
Government × on and after JAMA publication			1.32** (0.41)			6.47** (2.47)
Government × time trend after JAMA			0.07+ (0.04)			−0.38 (0.27)
Hospital characteristics						
Hospital ownership						
Not-for-profit hospitals (ref)						
For-profit hospitals	0.92 (0.95)	0.90 (0.95)	0.71 (1.06)	4.06 (2.47)	3.88 (2.44)	3.97 (2.61)
Government hospitals	−0.76 (0.71)	−0.78 (0.71)	−2.36** (0.89)	−1.35 (3.08)	−1.39 (3.12)	−3.81 (3.47)
Teaching status						
Non-teaching hospitals (ref)						
Teaching hospitals	−0.07 (0.66)	−0.25 (0.73)	0.05 (0.58)	−5.96* (2.34)	−4.77* (2.43)	−5.69* (2.36)
Number of births (annual)						
1,401–3,700 births						
≤1,400 births	0.46 (0.45)	0.46 (0.45)	0.47 (0.44)	−1.33 (1.73)	−1.36 (1.72)	−1.24 (1.78)
>3,700 births	−0.04 (0.37)	−0.03 (0.37)	−0.03 (0.37)	2.26 (1.52)	2.36 (1.51)	2.44 (1.52)
Maternity ward capacity (annual births per bassinet)						
66–130 births						
≤65 births	−0.17 (0.25)	−0.15 (0.25)	−0.12 (0.25)	−0.30 (1.11)	−0.26 (1.11)	−0.18 (1.08)
>130 births	0.07 (0.30)	0.09 (0.30)	0.13 (0.32)	−0.10 (1.20)	−0.33 (1.20)	−0.08 (1.21)
Obstetric care level						
Non obstetric hospital (ref)						
Obstetric level 1	0.05 (0.36)	0.06 (0.36)	0.13 (0.34)	0.72 (1.93)	0.75 (1.91)	0.88 (1.93)
Obstetric level 2	0.31 (0.30)	0.31 (0.30)	0.32 (0.30)	2.59+ (1.55)	2.57+ (1.52)	2.71+ (1.52)
Obstetric level 3	0.67* (0.33)	0.66* (0.33)	0.54+ (0.32)	1.91 (1.51)	2.20 (1.46)	1.81 (1.42)
Patient characteristics						
Medicaid (reference gp)						
Self-pay/no charge	1.62** (0.32)	1.62** (0.32)	1.60** (0.32)	4.00** (1.21)	4.01** (1.20)	4.01** (1.21)
Private insurance	4.44** (0.20)	4.44** (0.20)	4.43** (0.20)	6.44** (0.74)	6.45** (0.74)	6.44** (0.74)
Age 18–24 (reference gp)						
Age 25–29	−3.62** (0.17)	−3.62** (0.17)	−3.62** (0.17)	−7.59** (0.62)	−7.60** (0.62)	−7.59** (0.62)
Age 30–34	−4.56** (0.21)	−4.56** (0.21)	−4.56** (0.21)	−10.83** (0.71)	−10.84** (0.71)	−10.84** (0.71)
Age 35 and above	−4.46** (0.23)	−4.46** (0.23)	−4.46** (0.23)	−13.85** (0.91)	−13.85** (0.91)	−13.84** (0.91)
White (reference gp)						
Black	−6.56** (0.28)	−6.56** (0.28)	−6.55** (0.28)	−13.53** (0.99)	−13.56** (1.00)	−13.54** (0.99)
Hispanic	−3.61** (0.23)	−3.61** (0.23)	−3.61** (0.23)	−3.59** (0.67)	−3.59** (0.67)	−3.58** (0.66)

Table 2 continued

Coefficient (SE)	Spontaneous delivery			Operative delivery		
	(1)	(2)	(3)	(4)	(5)	(6)
Other races	4.42** (0.55)	4.42** (0.55)	4.43** (0.55)	4.23** (0.92)	4.25** (0.92)	4.22** (0.92)
Unknown races	−0.02 (0.38)	−0.01 (0.38)	−0.03 (0.38)	4.02** (1.18)	4.06** (1.17)	4.02** (1.19)
Baseline episiotomy rate	21.77** (0.41)	21.80** (0.42)	21.96** (0.42)	61.14** (1.63)	60.97** (1.61)	61.23** (1.67)
N	4,700,430			76,883		

* $p < 0.05$

** $p < 0.01$

$^{+}$ $p < 0.1$

cross-hospital variation in episiotomy rate is negative in both cases (−0.6 for spontaneous deliveries and −0.3 for operative deliveries), and rejected the null hypothesis that interhospital variation was unchanged over time.

Conclusions

There has been a gradual decline in episiotomy rates over the period 2003–2008. The systematic review by Hartman et al. and the subsequent change in the ACOG guidelines for episiotomy appears to have had limited impact on episiotomy rates. Specifically, publication of the Hartman et al. review was associated with a 1.5 percentage point decline in episiotomy rates, but publication did not alter the long-run rate of decline. This might be due to the fact that even though Hartman et al. study received wide media attention, there were smaller studies reaching similar conclusions preceding its publications, and therefore limit its potential effect. Of course, it is impossible to know what would have happened to the episiotomy rate if the Hartman et al. review had never been published. If the trend line would have leveled off after 2005 instead of continuing to decline, then the Hartman et al. review should be credited with a larger impact on episiotomy rates.

Our analysis is based on the State Inpatient Databases from eight states representing 36 % of the US population. The SID capture the universe of hospitalizations from these states across the 6-year study period, and so observed trends in episiotomy rates cannot be attributed to sampling variability. The data do not capture birth order. We would expect episiotomy rates to be higher for the first birth. It is unlikely that changes in birth order account for trends in episiotomy rates; the proportion of deliveries for first births has remained steady over time (27 % in 2003 and 28 % in 2008) [32].

Another concern with our results is that there might be co-temporal changes in obstetric practices that coincide with the release of Hartman et al. study, and those changes might confound our results. There are two potential factors that are particularly relevant—changes in hospital accreditation criteria by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) and changes in practice

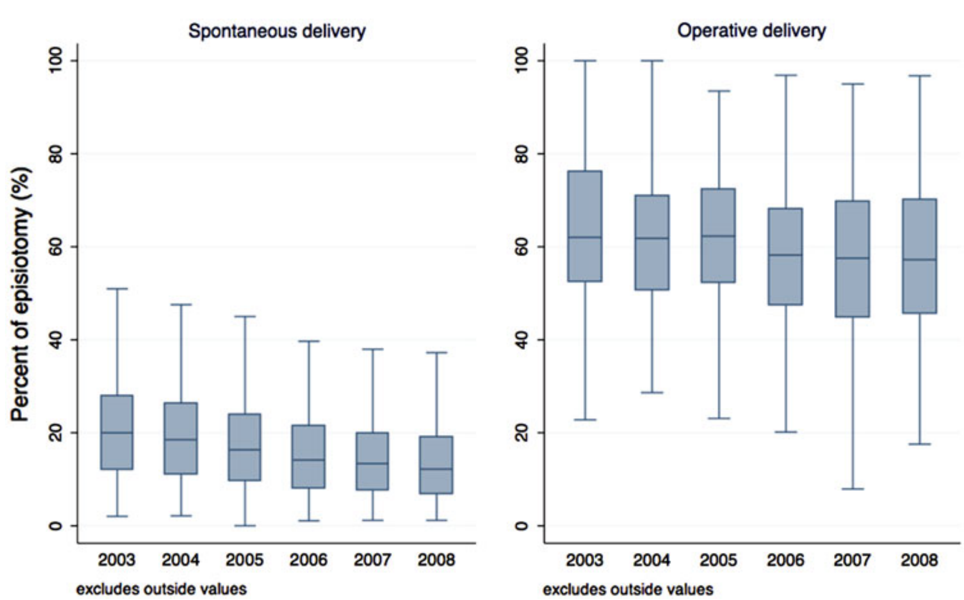


Fig. 2 Percent of episiotomies by hospital: 2003–2008

recommendations by ACOG. JCAHO added perineal trauma, among other clinical measures, as a quality indicator in 2002 for purposes of accreditation. Hospitals may have altered their use of episiotomy in response. However, the quality indicators did not change during our study period, and its effect would have been captured by the time trend included in our model. We reviewed practice bulletins of the ACOG around the study's publication date (2nd and 3rd quarters of 2005), and did not find practice recommendations that would confound the results.

The gradual decline in episiotomy rates suggests that evidence of harms from routine episiotomy have influenced practice patterns slowly over time, and a single study with wide media coverage did not necessarily give a boost to the recommended practice. This result is in contrast to other cases, where negative results did influence practice patterns. For example, there is an immediate decline in atypical antipsychotics use among elderly patients with dementia after the US Food and Drug Administration (FDA) issued an advisory and subsequent black box warning regarding the risks [24]. Trials reporting negative results for intermittent positive pressure breathing therapy [33], high-dose chemotherapy/hematopoietic cell transplants for women with breast cancer [34], PCI for patients with stable angina [35], and arthroscopic surgery for osteoarthritis of the knee [36] have led to reductions in the use of these procedures in a timely fashion.

An interesting finding from our analysis is that government hospitals appear to have smaller response to such a study compared to private hospitals. It is possible that physicians practicing in government hospitals are systematically differ from those practicing in private hospitals or that cultural differences across institutions affect physicians' acceptance of evidence-based medicine [22]. However, our data do not contain physician information to investigate the reasons behind the differential trend across hospital ownership.

Despite the gradual decline in episiotomy rate, many women have and continue to receive episiotomy, where the evidence suggested the harms outweigh any potential benefit. Hartman et al. recommend that hospitals try to reduce their episiotomy rates to 15 %. Even by the end of 2008, about 1/3 of the hospitals had episiotomy rates that are above this level for spontaneous deliveries, and 3/4 of the hospitals exceeded this recommended threshold for operative deliveries. Although it is impossible to know whether CER for other procedures would have more significant or immediate effect on practice patterns, the experience of episiotomy illustrates that in some cases, it might be overly optimistic to expect CER and evidenced-based medicine to reduce use of unnecessary procedures in a timely fashion.

Conflict of interest The authors report no conflict of interest.

Appendix

See Table 3.

Table 3 Comparison of adult female population (18 or older) between analytical sample and national average

	Eight SID states	National
Race distribution (%)		
White	56	65
Black	11	13
Hispanic	23	15
Other races	10	7
Female age distribution		
18–24	8	8
25–29	6	6
30–34	6	5
35 and above	81	81
Total adult female population	64,515,540	180,444,279

The US Census Bureau, Population Division, Annual Estimates of the Resident Population by Sex and Selected Age Groups for the United States, Arizona, California, Florida, Massachusetts, Maryland, New Jersey, New York and Washington: 1 July 2009, June 2010

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